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ABSTRACT

This paper reports the procedures, results, and conclusions of a study of the effects of two instructional strategies on three aspects of preservice science teacher behavior: (1) the number of divergent and evaluative questions asked, (2) the proportion of divergent and evaluative questions asked, and (3) the total number of questions asked. The subjects were preservice science teachers enrolled in a methods course. Two instructors and two strategies were randomly assigned to the four groups. Following instruction, two post-tests were made, each following one phase of instruction. The first phase included reading the instructional program, and either categorizing or designing questions. The second phase included a conference with the instructor, during which each student discussed his questioning behavior. The investigator categorized questions into (1) cognitive-memory and convergent, and (2) divergent and evaluative from tape recordings made of 15-minute science lessons presented by the subjects. The major findings were that (1) instruction in classifying and designing questions significantly and positively affected both the number and proportion of divergent and evaluative questions asked and (2) conferences between the instructor and the student teacher were more effective in affecting the divergent and evaluative questions asked when used with the formal instruction presented. Bibliography. (LC)

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Instruction on Questioning

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Focus: Teacher Education
Pre-Service

Purpose: This investigation included studying the effects of two instructional strategies on three aspects of preservice science teacher behavior: (1) the number of divergent and evaluative questions asked; (2) the proportion of divergent and evaluative questions asked; and (3) the total number of questions asked. Both strategies included the same programmed instructional booklet; however, the instruction that followed the reading of the program differed among strategies.

Procedures: A pretest was used to measure the entry behavior of preservice science teachers in four experimental groups. Following instruction, two posttests were made, each following one phase of instruction. The first phase included reading the instructional program, a handout describing the categories of questions, and either categorizing or designing questions. The second phase of instruction included a conference during which each preservice science teacher discussed his questioning behavior with the instructor. A fifth group (control) did not receive formal instruction on questioning, but did meet in conference with the instructor and received the handout describing the categories of questions used during this study. The investigator categorized questions from audio tape recordings made of 15-minute science lessons presented by the preservice science teachers. For purposes of data analysis, questions were categorized into either of two categories: (1) cognitive-memory and convergent; or (2) divergent and evaluative.

Analysis of variance and t test were the experimental designs used to test the significance of the variables studied. Instructors and proportion of divergent and evaluative questions asked during the pretest were used as covariables.

Major Conclusions:

1. Instruction in classifying questions asked and instruction in designing questions significantly and positively affected both the number and proportion of divergent and evaluative questions asked.
2. Instruction in the use of divergent and evaluative questions significantly and negatively affected the total number of questions asked.
3. Conferences between the instructor and the preservice science teacher were more effective in affecting the divergent and evaluative questions asked when used in conjunction with the formal instruction presented during this investigation.

Educational Importance: Divergent and evaluative questions focus attention on something more than regurgitation of factual information and produce divergent and evaluative thought in students. The implication that appears to be suggested from this research is that instructors can use either instructional strategy to increase the use of divergent and evaluative questions asked by preservice science teachers.

Prospectus

One of the most important challenges in education has increasingly become that of improving the quality and relevance of teacher preparation. Preservice teacher preparation should make provisions for technical skills deemed important to the science teacher. Questioning is one of the most important skills that a teacher can possess.

Educators and teachers agree that the questions asked in the classroom should stimulate thinking. Yet, the interpretation of collected data seems to indicate that although teachers, including science teachers, believe they are asking thought provoking questions, they are, for the most part, asking questions which requrie little more than factual recall.

This investigation included studying the effects of two instructional strategies on the use of divergent and evaluative questions asked by preservice science teachers. Divergent and evaluative questions focus attention on something more than regurgitation of factual information and produce divergent and evaluative thought in students.

Definition of Terms

Terms which apply to this research are defined as follows:

1. A question is any interrogative verbal action made which has the overt intention of soliciting a response, excluding rhetorical questions.

2. Cognitive-memory questions elicit the simple reproduction of facts, formulas, and other content through such processes as recognition, rote memory, and simple recall.

3. Convergent questions involve students in analysis and/or integration of given or remembered information or data. These questions lead to one expected end result or answer because the individual is asked to respond within a tightly structured framework.

4. Divergent questions require intellectual operations in which the individual is free to generate his own data or information on an individual basis. The individual is asked to take a new direction or perspective on a given topic.

5. Evaluative questions require judgment, value, or choice and are particularly characterized by their judgmental quality.

Procedures

Description of Population

The subjects used in this study were preservice science teachers enrolled in Methods of Teaching High School Science at a large midwestern university.

Instructors

Two instructors gave instruction during this investigation. Both instructors were doctoral candidates in science education and laboratory instructors in Methods of Teaching High School Science. One of the instructors was the investigator.

Pretest

Each preservice science teacher in the experimental group presented three science lessons on the same topic. The pretest was the first science lesson taught. The investigator categorized questions from audio tape recordings made of the science lesson presented by each subject.

This information was used to determine the propprtion of divergent and evaluative questions asked by each subject. This proportion was determined by dividing the sum of divergent and evaluative questions asked by the total number of questions asked. The median split was used to group subjects as high and low based on this proportion.

Assignment of Subjects, Instructors, and Strategies

The subjects were enrolled in two intact classes. The subjects in each class were leveled as high and low based on the proportion of divergent and evaluative questions asked during the pretest. An equal number of high-ranking subjects and low-ranking subjects were randomly assigned to two groups within each intact class. This procedure resulted in four groups. Two instructors and the two strategies were randomly assigned to the resulting four groups.

Posttests

Two posttests were used to collect data from the experimental group. The second science lesson was presented after administration of the strategies. The second posttest was made during the third science lesson.

During the interim between the second and third science lesson, each subject in the experimental group met, in conference, with his laboratory instructor. The instructor and the student discussed the questioning practices of the student in relation to the use of divergent and evaluative questions.

The student was advised that frequent use of divergent and evaluative questions in science teaching was desirable.

Control Group

A control group received only informal instruction on questioning. This instruction included a handout describing categories of questions and the same teacher-student conference described above.

Data and Instrumentation

The investigator categorized questions from audio tape recordings. These recordings were made of science lessons presented by the subjects during this study. For the purpose of data analysis, questions were categorized into either of two categories: 1. cognitive-memory and convergent; or 2. divergent and evaluative.

Strategies

Two strategies were designed by the investigator. Both included three days of instruction on questioning. The length of each "day" of instruction was one hour and forty-five minutes--an equilivant of six class hours of instruction was given.

The first day of instruction was the same for both strategies. The second and third days of instruction differed.

Strategy 1

First day. The first day of instruction was designed to develop an awareness of the value of questioning.

Introduction to the categories of questions was also given to the subjects by means of a programmed instruction booklet.

The objective of this program was to develop the ability to categorize questions as cognitive-memory, convergent, divergent and evaluative. Following the reading of the programmed instruction booklet, the instructor led the class in a discussion regarding the categories of questions.

Second day. The purpose of the second day of instruction for Strategy 1 was to further develop the skill of classifying questions. Recordings of science lessons were played from audio tapes. The subjects listened to, categorized and discussed the questions asked during these science lessons.

Third day. The third day of instruction for Strategy 1 included classifying questions from audio tape recordings and a discussion of the types of questions that should be asked in the science classroom.

Strategy 2.

First day. Same as Strategy 1

Second day. The purpose of Strategy 2 was to develop the ability of subjects to design questions for inquiry-discovery type science classes. Each subject was given a handout which included problem situations. The subjects worked in pairs and wrote five questions for each of the four categories of questions used during this study.

Third day. During the third day of instruction for Strategy 2, two groups of students evaluated and categorized the questions developed by their peers during the previous day of instruction. The latter portion of the class period was used for a discussion on the use of divergent and evaluative questions.

Analysis of Data

The description of the analysis of data is divided into two sections: The Effects of Formal Instruction, and the Differences between Formal and Informal Instruction.

The Effects of Formal Instruction

The mean number of divergent and evaluative questions asked during the pretest and two posttests was determined for each strategy. The results of this analysis are reported in Table 1.

Table 1. Formal Instruction X Strategies, Mean Number of Divergent Evaluative Questions Asked.

	Formal Instruction		
	Pretest	Posttest 1	Posttest 2
Strategy 1	4.45	7.90	7.45
Strategy 2	6.03	7.10	8.23

An examination of Table 1 permits one to conclude that there was an increase in the mean number of divergent and evaluative questions asked after formal instruction on questioning was given.

A two-way analysis of variance with repeated measures was used to study the systematic effects attributable to differences between each of two strategies, the effects attributable to formal instruction and their interaction effects. It was concluded that formal instruction had a significant systematic effect (beyond the .01 level) on the number of divergent and evaluative questions asked. It was also concluded that there were neither differences between strategies nor significant interaction effects on the number of divergent and evaluative questions asked.

The mean proportion of divergent and evaluative questions asked during the pretest and two posttests was determined for each strategy. The results of this analysis are reported in Table 2.

Table 2. Formal Instruction X Strategies. Mean Proportion of Divergent and Evaluative Questions Asked.

	Formal Instruction		
	Pretest	Posttest 1	Posttest 2
Strategy 1	.2237	.3733	.4270
Strategy 2	.2491	.3484	.4506

An examination of Table 2 permits one to conclude that there was an increase in the mean proportion of divergent and evaluative questions asked following formal instruction.

An examination of Table 2 permits one to conclude that there was an increase in the mean proportion of divergent and evaluative questions asked following instruction.

A two-way analysis of variance with repeated measures was used to study the systematic effects attributable to differences between each of two strategies, the effects attributable to formal instruction, and their interaction effects. It was concluded that formal instruction had a significant systematic effect (beyond the 0.001 level) on the proportion of divergent and evaluative questions asked. It was also concluded that there were neither differences between strategies nor significant interaction effects on the proportion of divergent and evaluative questions asked. The means for the total number of questions asked during the pretest and two posttest were determined for both strategies. The results of this analysis are reported in Table 3.

Table 3. Formal Instruction X Strategies. Mean Total Number of Questions Asked.

	Formal Instruction		
	Pretest	Posttest 1	Posttest 2
Strategy 1	20.31	20.83	15.86
Strategy 2	22.77	20.43	19.03

An examination of Table 3 permits one to conclude that there was a decrease in the total number of questions asked after formal instructions was given.

A two-way analysis of variance with repeated measures was used to study the systematic effects attributable to differences between each of two strategies, the effects attributable to formal instruction, and their interaction effects. It was concluded that formal instruction had a significant effect (beyond the .01 level) on the total number of questions asked. It was also concluded that there were neither differences between strategies nor significant interaction effects on the total number of questions asked.

Differences between Formal and Informal Instruction

The two-sided t test for independent samples was used to measure the differences between formal and informal instruction on questioning. The formal instruction consisted of Strategy 1 and Strategy 2. A control group received only informal instruction. Two posttests were made on the groups that received formal instruction and one posttest was made on the group that received informal instruction. The variable studied was number of divergent and evaluative questions asked during posttests. Means, variances, and number of subjects in each group are reported in Table 4.

The analysis of the data in Table 4 permitted the following conclusions:

1. Subjects who received Strategy 1 asked significantly (beyond the .02 level) more divergent and evaluative questions during the first posttest of the Strategy 1 group than subjects in the control group.

2. Subjects who received Strategy 1 asked significantly (beyond the .02 level) more divergent and evaluative questions during the second posttest of the Strategy 1 group than subjects in the control group.

3. Subjects who received Strategy 2 asked significantly (beyond the .001 level) more divergent and evaluative questions during the second posttest of the Strategy 2 group than subjects in the control group.

A two-sided t test for independent samples was used to measure the differences between formal and informal instruction. The formal instruction consisted of Strategy 1 and Strategy 2. A control group received only informal instruction. The variable studied was proportion of divergent and evaluative questions asked during posttests. Means, variances, and number of subjects in each group are reported in Table 5.

Table 4. Means and Variances of Formal and Informal Instructional Groups for Number of Divergent and Evaluative Questions Asked.

	Instruction				
	Formal				Informal
	Strategy 1		Strategy 2		Control
Posttest	1	2	1	2	1
Mean	8.030	8.032	7.086	8.507	4.136
	5.720	5.250	4.699	3.842	2.748
Number	33	33	35	35	22

Table 5. Means and Variances of Formal and Informal Instructional Groups for Proportion of Divergent and Evaluative Questions Asked.

	Instruction				
	Formal				Informal
	Strategy 1		Strategy 2		Control
Posttest	1	2	1	2	1
Mean	0.389	0.416	0.338	0.425	0.278
	0.199	0.236	0.189	0.198	0.186
Number	33	33	35	35	22

The analysis of the data in Table 5 permitted the following conclusions:

1. Subjects who received Strategy 1 did not ask a significently higher proportion of divergent and evaluative questions when the first posttest of the Strategy 1 group was compared to the posttest of the control group.

2. Subjects who received Strategy 1 asked a significantly (beyond the .05 level) higher proportion of divergent and evaluative questions during the second posttest of the Strategy 1 group than the control group.

3. Subjects who received Strategy 2 did not ask a significently higher proportion of divergent and evaluative questions when the first posttest of the Strategy 2 group was compared to the posttest of the control group.

4. Subjects who received Strategy 2 asked a significently (beyond the .02 level) higher proportion of divergent and evaluative questions during the second posttest of the Strategy 2 group than the control group.

Conclusions

The data analysis of this investigation permitted the following conclusions:

1. Instruction in classifying questions asked and instruction in designing questions significantly and positively affected both the number and proportion of divergent and evaluative questions asked.

2. Instruction in the use of divergent and evaluative questions significantly and negatively affected the total number of questions asked.

3. Conferences between the instructor and the preservice science teacher are more effective in affecting the divergent and evaluative questions asked when used in conjunction with the formal instruction presented during this investigation.

Implications and Discussion

The following implications, though not complete, appear to be suggested by and follow from the data and conclusions of this investigation:

1. Either instructional strategy (classifying questions asked or writing questions) can be used to increase the use of divergent and evaluative questions asked by preservice science teachers. The population consisted of a non-random sample of subjects from the same mid-western university. There exists no apparent reason to beleive that the students enrolled in the university studied are appreicably different from students enrolled in other universities.

2. The two instructors who taught both instructional strategies were equally successful in teaching each strategy. The provision of instruction increased the amount of time spent on divergent and evaluative thought processes.

3. Strategy 2, which included designing questions for a problem solving type classroom, may be a more desirable method of instruction. Although the means for this Strategy were not significently higher than the means for Strategy 1, which included classifying questions asked, most of the means for Strategy 2 were higher. The preference for Strategy 2 is also based on expressed opinions of the subjects within each of the groups, and the opinion of both instructors.

4. The instruction provided during this study increased the amount of time spent on divergent and evaluative thought processes during the science lessons taught. This implication was based on:

1. .. A significant increase in the proportion of divergent and evaluative questions asked; and 2. a significant decrease in the total number of questions asked. The increase in the proportion of divergent and evaluative questions asked suggested that proportionately more time was spent on these kinds of thought processes as represented by the responses given. Gallagher (1965) has shown that a light increase in the number of divergent and evaluative questions asked produces a much larger number of divergent and evaluative responses. Since the investigator has shown that the total number of questions asked was less after instruction on questioning, it seems to follow that there was a very large increase in the divergent and evaluative thought processes as represented by student responses.

The inference that more time was spent on divergent and evaluative processes was also based on the type of answer that is given to these types of questions. Cognitive-memory and convergent responses are often shorter than those given to divergent and evaluative questions. The latter types of questions more often permit many possible responses and usually more than one-word answers.

Recommendations

The following recommendations were made from the objective evaluation of the data and the investigator's subjective familarity with the study.

1. Collegiate science methods instructors should consider the use of one or a combination of both instructional strategies described in this study.

It would be meaningful to test the assumption that either strategy or a combination of the strategies could be successful in improving the habits of questioning of other preservice science teachers.

2. The effects of either and/or a combination of the strategies should be investigated for different populations. For example, instruction on questioning should be given to inservice science teachers, elementary school teachers, preservice elementary school teachers, methods students of other disciplines, and teachers of other disciplines.

3. Both instructional strategies used during this investigation included six class hours of instruction on questioning. An attempt should be made to determine if similar results could be obtained after three to four hours of instruction. This may be accomplished by either compressing the content of instruction and/or by assigning the reading of the programmed instructional booklet outside of the scheduled class time. Although subjects read the instructional program during class, there is no reason to believe that this reading cannot be completed outside of class time.

Appendix

Two Pages From Instructional Program

Divergent questions tend to increase student participation and more active thinking. Which of the following questions is divergent. (Note: when selecting your answer, consider the responses that could be given in a classroom situation.)

What things might increase the growth of a seedling?
(turn to page 48)
What are the three things that increase plant growth?
(turn to page 49)

The question, "What things might increase the growth of a seedling?" is <u>divergent</u>. You are correct. The teacher who asks this kind of question is likely to get many responses from students. Some students who respond to this kind of question may be those who are afraid to answer questions for which there are prescribed answers. Many students do not, under normal classroom situations, answer questions because they fear getting the wrong answer. By asking divergent questions, a classroom situation may be created in which the fear of giving wrong responses may be partially eliminated.

Bibliography

Gallagher, J. J. Productive thinking in gifted children. Cooperative research project, No. 965, Urbana, Illinois: University of Illinois, Institute on Exceptional Children, 1965.

Guilford, J. P. The structure of intellect. Psychological Bulletin, 1956, 53, 267-293.

Konetski, L. C. Instructional effect on questions asked by preservice science teachers. Unpublished doctor's dissertation. Bloomington, Indiana: School of Education, Indiana University, 1969.

Vygotsky, L. S. Thought and language. (Ed. & trans. by) E. Hanfmann & G. Vaker. Cambridge: MIT Press, Massachusetts Institute of Technology, 1962.

Waetjen, W. B. Learning and motivation implications for The teaching of science. Science Teacher, 1965, 32, 22-26

Watson, F. G. The teacher of science, in Secondary school teacher, by E. Stabler. Middletown, Conn. :Wesleyan University Press, 1962.